

BULLETIN

OF THE

Ohio Agricultural Experiment Station.

SECOND SERIES.—VOLUME V, NUMBER 4.

APRIL, 1892.

INSECTS WHICH BURROW IN THE STEM OF WHEAT.

Offices and Experiment Grounds on the Farm of the Ohio State University.

The Bulletin of this Station is sent free to all residents of the State who request it. Persons who receive duplicate copies of the Bulletin, or who do not care to receive any, are requested to notify the Station, as the edition is not sufficient to supply the urgent demand for it.

All correspondence should be addressed to EXPERIMENT STATION, Columbus, Ohio.

COLUMBUS.

THE WESTBOTE COMPANY, STATE PRINTERS.

1892.

OF THE

9

Abstract

*Prof. Webster is special agent of the U.S. Department of Agriculture, Division of Entomology, and is located at this Station.

BULLETIN

OF THE

OHIO AGRICULTURAL EXPERIMENT STATION.

VOL. V, No 4.

SECOND SERIES.

APRIL, 1892.

INSECTS WHICH BURROW IN THE STEMS OF WHEAT.

THE JOINT WORM—*Isosoma hordei*, Harris.

Notwithstanding the entomological literature of the country uniformly teaches us otherwise, the credit of original discovery of this species, as an enemy to grain, justly belongs to Mr. James Worth, of Sharon, Bucks county, Pennsylvania, who discovered the larvæ in 1821 while searching for the Hessian fly, and has given us the result of his observation as follows:

"I will now call the attention of agriculturists to another insect, very destructive to the wheat crop, which I discovered in the Spring of 1821, when searching after the Hessian fly. I have not yet completed its history, but have ascertained that it has three broods or generations in each year; the larva (small worm) of the first brood is found (in this climate) about the first of May in the cavity of the culm, near the root, where it causes an enlargement of the stem, and the plant declines as if affected by the fly—the second brood in June is lodged above the several joints in the cavity of the straw; this does not entirely destroy the stalk, but very materially injures its yield—the third brood is found among the plants that spring up in the stubble fields, or early sown crops in the fall, and lodged in the manner of the first brood."¹

Later, Mr. Joseph E. Muse described the adult as belonging to the Hymenoptera, and of the genus *Tenthredo*, or Saw flies.²

As the specific name would indicate, the adult insect was first observed by Dr. Harris as infesting barley straw, and was originally described as a parasite of some unknown insect supposed to be allied to the Hessian fly

¹ American Farmer, vol. 4, p. 394.

² Loc. cit., vol. 5, p. 113.

For several years prior to 1829, the barley crops in the counties of Essex and Middlesex, Massachusetts, had been seriously injured by small worms working in the growing plants, usually between the second and third joints, and when the plants were about eight or ten inches high. The first to call public attention to the matter in this particular locality was Hon. John Merrill, in the *New England Farmer*, under date of August 16th, 1829. The adult insects, and the fact that they were the adults of the larvæ found in barley straw, seem to have been observed for the first by Mr. John M. Gourgas, of Weston, Massachusetts.³ The species was first described in the *New England Farmer* of July 23d, 1830, as *Eurytoma hordei*, Dr. Harris being under the impression that they were parasitic, and that the true culprits were some species of *Ceratomyza*, but distinct from the Hessian fly. About 1844, a bed filled with barley straw developed a large number of adults which were so annoying to children occupying the bed that the straw was emptied out and burned.⁴ This was barley straw also, and up to 1851 there seems to have been no complaint of any similar injuries to any other of the closely allied grains, wheat and rye, in New England. About the year 1848⁵ there occurred in central Virginia, especially in the vicinity of Gordonsville and Charlottesville, a supposed new and most destructive enemy to wheat, whose depredations rivaled those of the Hessian fly. The first published account of the insect causing these last depredations, appeared in the *Southern Planter* of July, 1851, from the pen of its editor, Mr. Frank G. Ruffin, and was headed "The Joint-worm." The second article which was published regarding this insect appeared in the *Albany Cultivator* of October, 1851 (vol. 8, New series, pp. 321-4), by Mr. Alex. Rives, of Albemarle, Virginia, accompanied by the results of examinations, by Dr. Fitch, of some straws with which Mr. Rives accompanied his communication.

The insects infesting the wheat in Virginia were studied by Drs. Fitch and Harris, and by Profs. Cabell and Wyman, the result being that all except Dr. Fitch were inclined to the opinion that this was the same species as had been described by Dr. Harris as *Eurytoma hordei*.⁶ From this opinion Dr. Fitch seems to have differed, and afterwards described it as *Eurytoma tritici*.⁷ In the meantime the insect seems to have been greatly on the increase throughout the infested portions of Virginia, so much so that in 1854 a Joint-worm convention was held at Warrenton, for the purpose of devising some means of exterminating the pest.

³ Harris Rep Ins Mass., 1841, p. 433.

⁴ Loc cit, Ed 1852, p. 552

⁵ Fitch, 7th Rep Ins. N Y, Rep. N Y. St Ag Soc, 1861, p. 830.

⁶ Harris Ins Inj. Veg., 1852, pp. 554-61. Trans. N Y. St. Agr'l Soc. 1861, pp. 830-851.

⁷ Jour. N Y. St Agl. Soc., Vol. IX, p. 115.

About this time there appeared, in the barley fields of central New York, a disease similar to that affecting wheat in Virginia, and also the barley many years before in Massachusetts. The effect of the insect on the straw was identical, and from these Dr. Fitch reared an insect evidently closely allied to both of the species of the *Eurytoma* previously known to him, but differing somewhat in the color of the legs. On this distinction Dr. Fitch described simultaneously with his *Eurytoma tritici*, a third species which he termed *E. fulvipes*, on account of their more tawny legs.⁸

In August, 1860, Mr. Daniel Steck, of Lycoming county, Pennsylvania, transmitted to the American Agriculturist several pieces of rye straw containing larvæ of an insect which had appeared in his vicinity and threatened to injure the crop of this grain. In May of the following year other infested straws were also forwarded, and these were turned over to Dr. Fitch for information as to what the insect was. From these a third species—so called—was reared by Dr. Fitch and named by him *Eurytoma secalis*. In all three of his species no distinguishing characters of development or of anatomy were found, the descriptions being based on the difference in coloration of the legs, and, while the describer seems to have been convinced that these insects were not parasitic, but themselves the depredators, he seems fully decided as to the validity of all his species.⁹

In the years 1866 and 1867 the Joint-worm was very abundant in the barley fields in the vicinity of Grimsby, Ontario, Canada West, and was carefully studied by Mr. J. Pettit, who observed the females depositing their eggs in the stems of then healthy stalks of barley in the open field.¹⁰ A large quantity of the infested straws were sent to Mr. B. D. Walsh, who, from the same lot of straws and during the month of June, reared all of Fitch's species and also *I. hordei* of Harris, thereby settling the unity of the four so-called species. Mr. Walsh further concluded that the species did not belong to the genus *Eurytoma*, but to that of *Isosoma*, no member of which was known to be parasitic.¹¹

In the Rural New Yorker of May 9th, 1885 Prof. A. J. Cook, under the specific distinction of *nigrum*, describes still another coloral variety of this species.¹²

⁸ Loc cit.

⁹ American Agriculturist August, 1861, p 235.

¹⁰ Canada Farmer, 1867, p 268

¹¹ American Entomologist, vol. 1, pp 149-58.

¹² American Naturalist, vol XIX, pp 804-8.

The species is a true gull maker, although the extent to which this character is developed varies exceedingly. Harris stated of the earliest observed specimens of the work in barley that the presence of the larva was known by an oblong swelling on the surface of the straw, these swellings in some places greatly disfiguring the stem. These last were fully illustrated by Mr. Townsend Glover in the report of the Commissioner of Agriculture for 1854, plate 5, reproduced here in Fig. 1.

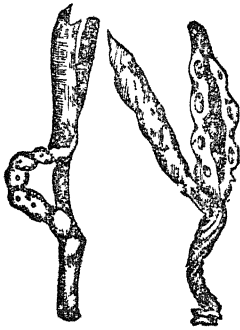


FIG. 1.

Wheat straw affected by joint worm. After Glover

Speaking of the effect on the wheat straws in Virginia in 1851, Dr. Fitch says that they might be like an enlarged tumor or only slightly elevated (fig. 2, *a*) and blister-like. Prof. Cook found that his supposed species affected the straw in much the same modified way, or perhaps still less prominently. The location of the larva in the straw may vary from the vicinity of the second joint, as recorded by Dr. Harris, in the sheath or lower portion of the stem, as recorded by Glover, or in the vicinity of every joint, except the uppermost, as observed by Prof. Cook.

So far as known this species is single brooded, the insect hibernating in the larval state. Dr. Andrew Nichols, of Danvers, Massachusetts, long ago observed that some adults emerged from the straws, in the fields in November, and Prof. Cook observed pupæ in the straw in September, in Michigan. In nearly all cases the data as to the appearance of the adults in summer have been based upon artificial breed-

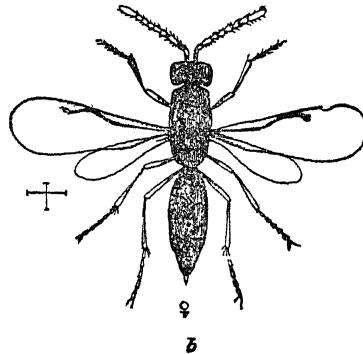
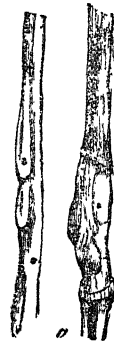


FIG. 2.

a, Wheat straw affected by joint worm *b*, Adult as seen from above. Line at side of all figures indicate life size.

ings, under unnatural environments, and the widely different dates given by different observers attests to their unreliability. As we shall show of an allied species, the last of one brood might mingle with the first of the second, although this may not be true of *hordei*.

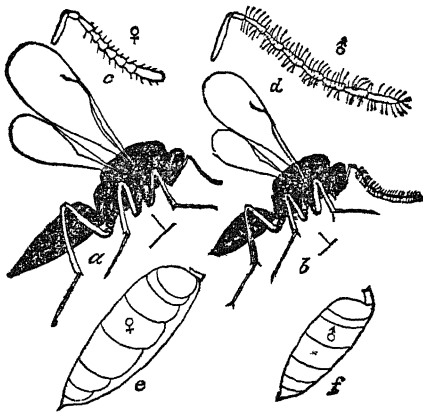


FIG. 3.

Adult of Joint Worm. *a*, female; *b*, male; *c*, antennae of female; *d*, do. of male; *e*, abdomen of female; *f*, do male. After Riley.

The adult insect is well illustrated by Fig. 3. They belong to the same order of insects as the bee, ant and wasp, but do not sting. The color is black except a spot on the shoulders, the legs, which are black and yellowish, and eyes reddish brown. The worms are yellowish white, with tips of mandibles or jaws brown, and their form is like those of the following species. The pupa also resembles that of *I. tritici*. Riley.

As the insect winters over in the stubble the remedy is obvious—burning the stubble. This may be done any time after harvest and before the 1st of March.

THE WHEAT STRAW WORM—*Isosoma tritici*, Riley.

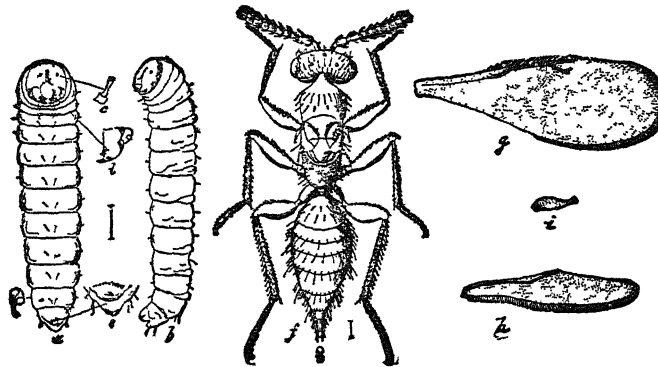


FIG. 4.

Isosoma tritici *a*, ventral view; *b*, side view of larva; *c*, antenna; *d*, mandible; *e*, anal joint beneath; *f*, adult female; *g*, fore wing; *h*, hind wing; *i*, aborted wing. After Riley.

In June, 1880, Mr. J. K. P. Wallace, of Andersonville, Tennessee, forwarded specimens of a small hymenopterous larva to Prof. Riley, with the statement that the straws in his wheat field were nearly every one affected by them, and, as a result, the straw was inclined to fall before the grain was ripe.¹³

¹³ Am. Ent., Vol. III, p. 181.

During the same season, wheat straws in the vicinity of Carbondale, Illinois, were found to be infested by larvæ evidently quite similar, and in some cases probably identical with those found in Tennessee.¹⁴

The following year, Prof. G. H. French reared from straws, from the Illinois locality, a hymenopterous insect belonging to the genus *Eupelmus*, but which he mistook for the real depredator, and described as *Isosoma allynii*. In March, 1882, Prof. Riley described his species, giving the points of difference between it and *I. hordei*, and also an account of the habits of the former, showing that Prof. French¹⁵ had described one of its parasites instead of the depredator itself. In the American Naturalist for March, 1882, Prof. Riley¹⁶ gave in substance his previous notice, figuring the larva, and comparing the species with the European *I. lunare*.

In the meantime Prof. French had reared a second Hymenopter, a true *Isosoma*, from a species of grass, *Elymus Canadensis*, and which he described as *I. elymi*.¹⁷ While, for a time, holding the opinion that this was also a depredator on wheat, he later learned and acknowledged his error and admitted that *tritici* alone was engaged in this work.¹⁸ So far, the species had only been observed in Tennessee, Wallace; Southern Illinois, Prof. French; Missouri, Mr. J. G. Barlow,¹⁹ and Virginia, Dr. Packard.²⁰ In September, 1882, Prof. Riley had received straws containing both larvæ and pupæ, from Mr. J. A. Starner, of Dayton, Columbia county, Washington Territory, from which *tritici* was afterwards reared. As early as 1879 Dr. Packard received specimens of what was probably the same species from Sonoma and Yolo counties, California.²¹

On September 25, 1883, Prof. French received from Stockton, California, a quantity of wheat straws seriously infested with both larvæ and pupæ of this species, from which the writer reared adults. On the 8th of May, 1884, while studying some other wheat insects, we found two females in a field of young wheat near Bloomington, Illinois.²² Other individuals were observed in the same field up to the 16th, eggs being found in the ovaries on the latter date, and oviposition witnessed on the 11th.

On the 28th, 29th and 31st, large, apparently nearly full grown larvæ, were found in the upper portions of growing plants, in one case a gall-like growth appearing where the head of the plant should have appeared.

A very large pupa was also observed in a precisely similar situation, and from this same field and also from one of rye, quite a number of

14 *Prairie Farmer*, Aug. 28, 1880

15 *Loc. cit.*, Dec 31, 1881.

16 *Rural New Yorker*, March 4, 1882.

17 *Can. Ent.*, Jan., 1882.

18 *Loc. cit.*, May, 1882.

19 *Rep Com Agr.*, 1881-2, p 65.

20 *Loc cit.*, p 183

21 *Am. Nat.*, 1882, p. 1017.

22 *Loc cit. Rep.*, 1884, p. 383.

very robust adults were captured, all possessing fully developed wings. Removing about the first of June to Indiana, we found this larger winged form of adult female quite abundant in fields of wheat, where they were ovipositing, and continued to do so until the 27th of the same month, after which none were observed. In his report as entomologist of the U. S. Department of Agriculture for 1884, Prof Riley²³ described this larger form as a distinct species, giving to it the name of *grande*. (Fig 5)

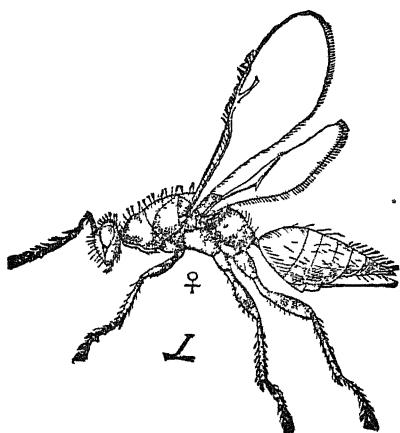


FIG. 5.

Isosoma tritici, female of summer brood, described as *I. grande*. After Riley.

A number of these females were placed in a large breeding cage with growing wheat plants. They were observed to oviposit in these, but the next spring there emerged from these straws nothing but wingless females of *tritici*.²⁴ In the autumn of 1885, a small plot of wheat was sown in a garden in the city of Lafayette, Indiana, and, although thus secluded at a considerable distance from any fields, it was further protected by a wooden frame covered with swiss muslin. In this way the plot was thoroughly protected from the visitations of insects of any sort, until the grain had fully ripened the next year. On the 12th of April, 1886,²⁵ several females of *tritici*

were placed in the inclosure. On June 2d, fifty-one days after, females of *grande* began to appear in the inclosure, and were observed to oviposit in the growing plants. (Fig. 6.)

These plants remained in the inclosure until fully ripe, when they were removed and divided, one part being retained and the other sent to Washington. From these straws there appeared on February 4, 1887, four females of *tritici*, two emerging in Washington and two in Lafayette, Indiana. This settled the relation of the two forms to each other. But still more had been accomplished. From stubble taken from an infested field near Lafayette, Indiana, August 12, 1885, and forwarded to Washington, there appeared during January and February, 1886, three males of *tritici*, thereby proving that to be the bi-sexual form.²⁶

Up to this time the summer form had been observed only by us in central Illinois and Indiana, and by Mr. H. Garman in Clark county, Illinois, the latter under date of May 21, 1884.²⁷ There seems, how-

23 Loc cit Rep 1884 p 358.

24 Loc cit Rep, 1885 p 312.

25 Loc cit. Rep. 1886, p 573.

26 Loc. cit., p 543.

27 14th Rep. St. Ent., Ill., p. 34.

ever, to be some quite valuable evidence going to show that this form occurred in southern Illinois long before the present species was thought of as inhabiting the western states, the observer, the lamented B. D. Walsh, having only a vague suspicion of the value of his "find."²⁸

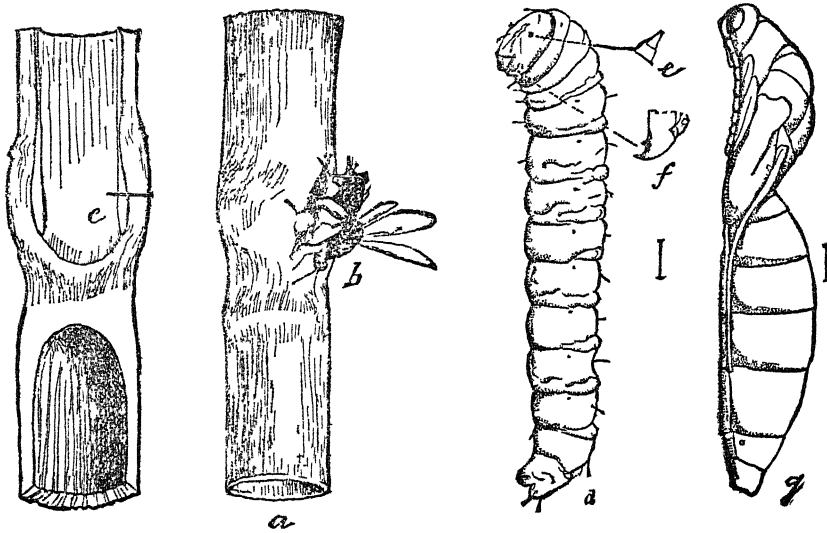


FIG. 6.

a, Section of wheat straw; b, female *Isosoma form grande* in act of oviposition; c, place where egg is deposited; d, larva or straw worm; e, antenna; f, jaw; g, pupa. After Riley.

Under the title of "A new insect in wheat," Mr. Walsh, in February, 1862, contributed for the Transactions of the Illinois State Agricultural Society, some observations on an unknown insect which he had, the preceding June, noticed in Union county, Illinois. While examining a field of stubble near Jonesboro for Hessian fly, he says: "To my great surprise, I also discovered several straws bulging out, notably above one of the lower joints, and on removing the swollen shank of the leaf, which is wrapped around the straw above the joint, I found that the straw itself was enlarged and often perforated by a hole of one-sixteenth of an inch in diameter. Inside the hollow bulge of these straws I found a bright, orange-colored, footless larva from three to four-sixteenths of an inch long."

Mr. Walsh figured both the galls and the larva found in them, the latter from memory, as he had unfortunately left his lens at home, and the specimens that he secured died. The figures of the affected straw certainly resemble those observed by us, and made by the larva of the

summer form *grande*, and also as found by Mr. Garman and described by Prof. Forbes. This larva observed by Mr. Walsh may not, however, have been that of an *Isosoma*, but of a parasite, as larvæ similar in appearance to that described by Mr. Walsh were observed destroying those of *Isosoma* in Benton county, Indiana, by us, but we failed to breed the adult insects.

At the time of writing the notice Mr. Walsh held the opinion, which he afterwards abandoned,²⁹ that the Joint-worm was a parasite, and that the larvæ which he had observed in the galls were the real depredators. He strongly suspected that these larvæ would develop a small beetle, *Brachytarsus variegatus*, Say. As Mr. Walsh himself states, the observations were very unsatisfactory, and lacking in exactness, his only purpose in placing them on record at all being, as he says, "with the hope that some other observer might be thereby induced to supply what is defective and correct what is erroneous" in his statements. It would be too much, even now, to say how far his hopes have been fulfilled. What is here given is believed to be the best solution until some one does better.

With our present knowledge of the habits of the two species of *Isosoma*, we may separate them on the method of affecting the straw. The first, that is the Joint-worm, develops in galls more or less apparent in the walls of the culm, while the latter, the wheat-straw worm, develops within the culm itself, forming no galls in the walls thereof, and there are fewer insects in the individual straw. Also, the first named winters, largely at least, as larvæ; the last in the pupal stage, and is two-brooded.

The summer or mono-sexual brood of *tritici* deposit their eggs, so far as has been observed, in or very close to a joint.³⁰ The females of the spring or bi-sexual brood, which we saw ovipositing in plants several inches in height, did not exhibit this selection. The location of their larvæ in the plants indicates that they select the young head, which, at the season when they deposit is usually only a short distance above ground. Therefore, the larvæ of the mono-sexual summer, or *grande* form are, more properly speaking, wheat-head worms instead of wheat straw worms. It is quite probable that the effect of this richer food is largely influential in heightening their development, as from plants in the stems of which the wingless females of the spring brood were observed to deposit their eggs on May 11th to 14th, we obtained other females on the 20th and 23d of June,³¹ varying but little in appearance from the normal form of

²⁹ Canada Farmer, 1867, pp 267-8, Am Ent. 1, p. 151.

³⁰ Rep. Com Agr, 1884, p 886.

³¹ Loc. cit, p. 885.

tritici as described. Hence, the question is at least an open one, as to whether or not if the eggs had been deposited in the young head, the adults might not have been more fully developed. The larvæ of the later brood usually feed near the joint, but they have been observed living in longitudinal burrows in the soft, inner walls of the culm, just beneath the inner epidermis, without, however, forming a gall there.

It might be well to state here that males of the spring brood occur but rarely, few having been observed by any one, while there seems to be none of this sex whatever among the summer brood, the only one of the two which is migratory.

In summing up the matter, it may be said that the wheat straw worm is two brooded—an exceptional character with this group of insects—the adults of the second brood being small, almost wholly wingless, and therefore, non-migratory, composed almost exclusively of females. These appear in early spring and deposit their eggs in the growing wheat, placing them, usually, in or near the embryo head. These produce worms which, in June, develop a brood (the first) composed wholly of females (so far as known), which are robust, and provided with fully developed wings, and, therefore, compose the migratory brood, and through them the insect is diffused over the country. These deposit their eggs in or near the joints of the straw, more frequently the second below the head. The worms from these reach maturity, and pass to the pupal stage in the fall to emerge in early spring as adults.

PREVENTIVES.

As with the joint-worm, these insects pass the winter in the stubble; therefore, burning this during fall or winter will, of course, destroy them. As the spring brood is wingless, for the most part, it will be seen at once that a rotation of crop will be very advantageous in preventing their occurrence.

PARASITES.

The most numerous parasite is *Eupelmus alynni*, French, but, besides this, *Stictonotus isosomatis*, Riley, a species of Dryinus and a Pteromalid have been reared. Besides, the larvæ of a small Carabid beetle, *Leptotrichelus dorsalis*, devours many of the worms which are exposed by the cutting of the grain. A species of mite, *Heteropus ventricosus*, Newport, also attacks the pest in the same manner.

Both the joint-worm and the wheat straw worm occur in Ohio, and have again and again been reported as being seriously injurious. Where the damage is not great they are frequently not observed, owing to their secluded habit, and often the injury done by them is attributed to other causes.



FIG. 7.

The wheat saw-fly, *Cephus pygmaeus*. *a*, female beginning to oviposit; *b*, female with ovipositor inserted in straw; *c*, insect with wings expanded; *d*, straws cut by larvæ; *e*, larva in cell at base of straw. After Comstock.

THE WHEAT-STEM SAW-FLY—*Cephus pygmaeus*, Linn.

This is a new depredator in the wheat fields of the American farmer, its first appearance being recorded from central New York in 1889. While I have no proof of its occurrence in Ohio, very suspicious reports have come from Ashtabula county last year, just where we should most expect its appearance, and if it has not already gained a foothold in the State it most assuredly will do so, sooner or later. The insect and its method of working are fully illustrated in Fig. 7, used here through the courtesy of the director of Cornell University Experiment Station.

The species was first described by Linnæus as *Sirex pygmaeus* in his *Systema Naturæ* 12th edition, in 1766, though it seems to have been observed in the environs of Paris in 1764.³² Just when the larvæ first became known as destructive to grain is not apparent, but it was not until 1819 that M. Dugaigneau, a skillful agriculturist of the department of Loire, France, "made known the metamorphoses of the species, and the changes it produced in the wheat."³³ Later, another French gentleman, M. Herpin, investigated the subject, evidently quite thoroughly.³⁴ In *Species des Hymenopteres*, Tome Première 1879, p. 537, M. Ed. André gives the following as the geographical distribution: England, France, Spain, Holland, Switzerland, Tyrol, Italy, Germany, Hungary, Russia, Sweden, Circassia, Syria. Curtis in his *Farm Insects* (1860), notices the species at some length, stating that he had for many years observed it in England, though his notice is taken largely from the publication of M. Herpin. However, that zealous and indefatigable guardian of the entomological interests of the English husbandman, Miss Eleanor A. Ormerod, in her admirable series of annual reports has not left us in the dark in regard to the workings of this insect during the last 14 years.³⁵ From these reports we learn that while the pest occurs every year to a greater or less extent, it is not seriously destructive every year, or over any great area at the same time, and seems to be more pronounced in localities that appear to be the most congenial to Chlorops—an insect similar to our wheat stem maggot—and the Hessian fly.

The first knowledge we have of the appearance of this pest in America, was published by Prof. J. H. Comstock of Cornell University, Ithaca, New York. Prof. Comstock states that the species was first observed in the vicinity of Ithaca in 1887 by a student of the university, and, in the

³² Geoffroy, *Histoire des insectes des environs de Paris* 2 Vol in —4 22 pl col Paris

³³ *Annales de la Soc des Sciences Belles Lettres et Arts d'Orleans*, Vol 1, p 121

³⁴ *Memoire sur divers Insectes nuisibles a l'Agriculture*, par J. Ch. Herpin

³⁵ *Report of Observations of Injurious Insects and Common Farm Pests with methods of Prevention and Remedy*, 1-14, by Eleanor A. Ormerod, F. R. M. S. &c, 1877-1891

two years following had become very abundant.³⁶ Mr W. Hague Harrington states that he swept adults from a meadow, presumably in the vicinity of Ottawa, Canada, in 1887, and received them from the vicinity of Buffalo, New York, where they were collected by Mr. Van Dusee in June of 1888, and also 1889.³⁷

From the information given us in the former publication it appears that the insect passes the winter in the larval state, having reached its full growth in this stage the preceding July, and forms a cocoon in which it pupates, probably in March and April. The adults emerge in May and deposit their eggs, frequently several in a straw, and more often in the upper portion, during the same month. At whatever point in the straw the eggs may be placed, with the maturing of the straw the larvæ make their way to the lower portion thereof, near the roots, and before entering their cocoons provide for their escape, as adults, by girdling the stems from within. No experiments appear to have been made with a view of destroying the insects. Two parasites were observed, but not identified. From the statements made, the damage to the grain would appear to consist in weakening the straw, and causing it to lodge.

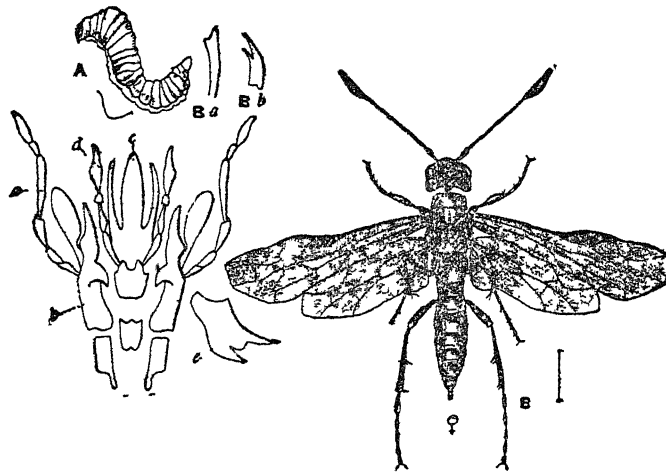


FIG. 8.

Cephus pygmaeus L. A, larva; B, adult female, Ba, one of the anterior spurs of adult; Bb, claw of adult; a, six-jointed maxillary palpus; b, bilobed jaw, c, trilobed lip, d, four-pointed labial palpus. After André.

Prof. Comstock found that in the latitude of central New York the adults (fig. 8, b) emerged from the stubble about or a little before the

³⁶ Bull. Cornell Univ. Expt. Station, XI, November, 1889

³⁷ Can. Ent., Vol. 22, p. 40.

middle of June, just as the heads of wheat were being put forth from the terminal sheath. The eggs were deposited almost anywhere in the stem, but chiefly in the upper portion. In whatever part of the straw the larva happened to hatch, it ultimately worked its way downward, and by the 19th of July all appeared to have reached the base, and nearly all had passed below the lower joint by the 15th. The larva, or worm, (fig. 8, *a*) does not pass out of the straw, but, at the extreme bottom, it constructs a cocoon (see *e*, fig. 7), but before doing this it girdles the straw from within, some distance above, in order to facilitate its exit after it has transformed to the adult.

PREVENTIVES.

It will be observed that this insect is much like the two preceding in habits, and especially in that it passes the fall and winter in the stubble. Hence, burning the latter will destroy at least a large number. It seems probable that the sooner this is done the better, if possible before the worms have reached the lowest extremity of the straw, else the earth about the plant might protect a part of them. Stubble does not burn readily at that season of the year, and, therefore, it might be necessary to run the mower over the field, and after a day or so in a hot dry sun, it would probably burn sufficiently well to destroy the insects, especially if the grain were cut rather high. Deep, fall plowing might prove effective, in which case it will probably be found advisable to use a jointer in order to thoroughly cover the stubble. Even a rotation of crops would probably be of some benefit.

THE GRAIN SPHENOPHORUS—*Sphenophorus parvulus*, Gyll.

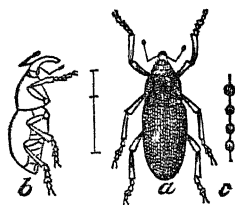


FIG. 9.

The Corn Sphenophorus,
Sphenophorus sculptilis,
Uhler. *a*, back view;
b, side view; *c*, eggs.
After Riley.

This species is very different from any of the preceding and a relative of the Plum Curculio, attacking wheat, oats and barley, but does little injury to these grains, and is included here because of its liability to be confused with the preceding. We have also found it eating the bulbous roots of timothy, and puncturing the stems of young corn. The adult insect is black and the general form and size is very well illustrated by Fig. 9, which relates to a closely allied species. The female punctures the lower part of the straw at a little distance above the roots and places her egg therein. This is done,

probably, during late May or in June, but oviposition has been observed as late as July 1st. This portion of the stem is of a more or less solid nature and the young larva hatching from the egg finds an abundance of

succulent food. By the time the worm has reduced the inner substance of the straw to powder it has become too large for its burrow, and, therefore, eats its way out and finishes its growth by subsisting on the roots, often destroying a whole clump or stool in this way. When full grown these larvæ leave the roots, and, working their way to one side, construct an earthen cell in which they pass to the pupal stage, from which, after two or three weeks, they pass to the adult stage. We have reared these adults from wheat stubble in August. The worms are short, robust, with small brown heads, and with this description can hardly be confused with any other insect.

There are quite a number of species of these beetles, several of which are sometimes very destructive to growing corn in various portions of the United States.

THE STALK-BORER—*Gortyna nitela*, Guen.

This is another insect which usually does little injury to the smaller cereals, yet occurs often enough, and, sometimes, in sufficient numbers to attract attention. The worms shown in 2 and 3 of Fig. 10 are well nigh omnivorous, and a list of shrubs and plants which they do not attack would be more interesting and



FIG. 10.

Heart-worm or stalk-borer, *Gortyna nitela*, Guen. 1, adult; 2, 3, larva.

less extensive than one including those on which they are known to depredate. As the name would indicate, the larva works within the stems of plants and is generally observed when it changes its habitation from one plant to another, when it is best represented by 2, Fig. 10; but when nearer fully fed it will be found to be better represented by 3

The species was described in 1852,³⁸ though the depredations of its larvæ, unknown as such, had attracted the attention of Dr. Harris as early as 1848,³⁹ who observed it burrowing in potato stalks and described it in that connection. There is, however, good evidence of its destructive

³⁸ Sp. Gen. Lep. V. Noct i, 1852, p. 124.

³⁹ Entomological Correspondence, p. 315.

habits in wheat, long prior to this date. Mr. Jabez Jenkins, of West Whiteland, Chester county, (Pa.?) observed its work in wheat straw and called attention thereto in 1840,⁴⁰ while Mr. Thos. Beesley writing from Cape May June 27th, 1823, speaks of a worm which eats into the "straw at the second or third joint."⁴¹

As previously stated, the injury to the smaller cereal grains is usually very slight and mostly confined to the margins bordering on grass lands. One case is however on record where serious injury was sustained to a small field of wheat near Madison, Wisconsin, where the grain was entirely ruined.⁴²

The full life history of the species is not known, but it is supposed to pass the winter in the adult stage. At any rate we have found very young larvæ working in the stems of young oats, below the surface of the ground in April in central Illinois, the field having been devoted to corn the previous year.⁴³

The worms are, when young, of a livid hue with light stripes along the body, the one on the side being interrupted toward the head (See 2, Fig. 10). The moth is of a general mouse gray color with a light band on each fore wing as shown in the figure. There is no known remedy for these insects in the fields, and cutting out is resorted to in case the plant is a valuable one, in the garden and lawn. Prof. J. A. Lintner records a single instance where the larva so far departs from its normal habit as to become an external feeder, in this manner depredating upon corn.⁴⁴

THE WHEAT STEM MAGGOT—*Meromyza Americana*, Fitch.

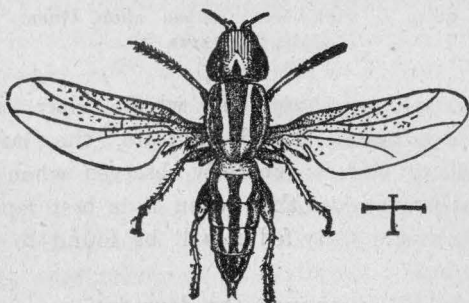


FIG. 11.

Meromyza Americana, adult. After Forbes.

The adult insect (Fig. 11) was described in 1856 among quite a number of other species of flies, obtained in wheat fields during the month of June. The author of the description had no exact knowledge of the appearance of the larvæ beyond the fact of his having "observed, at different times during the season, smooth, shining, footless little maggots, of green and

40 Farmers' Cabinet, vol. 5, p. 68, 1840.

41 American Farmer, vol. 5, p. 165.

42 Le Baron, Second Rept. State Entomologist of Illinois, p. 141.

43 Rep. Comm. Agr., 1884, p. 392.

44 New England Homestead, July 12, 1883.

watery-white colors, commonly embedded in the straw in small burrows or cylindrical channels which they have excavated." He himself says that it would be scarcely worth while to state the situation in which one and another of these worms were found, and the manner in which it mines or otherwise injures the straw, until the particular species could in each case be identified with the adult. Dr. Fitch states that he had discovered these flies in 1855 in his neighborhood, and states that wheat hitherto had not been known to suffer from attacks of insects of this sort in this country.⁴⁵ This is certainly a slip of the pen, as larvæ, undoubtedly of this species, were accused of injuring wheat in Pennsylvania as early as 1821, by Mr. James Worth, of Bucks county.⁴⁶ There is almost equally good evidence that this same insect affected wheat, visibly, in Michigan as early as 1845. The following notice is said by Prof. Forbes to occur in the volume of the *Prairie Farmer* for that year, page 216:

"A NEW WHEAT INSECT.—The Michigan Farmer notices a new wheat insect found preying upon the wheat in that state, and which is described as follows: It is the product of a small, greenish fly, about three-sixteenths of an inch in length. The larva is a white worm, one-fourth of an inch long, ribbed,—segmented?—without feet, with two forked, black lines on its forehead, and in some cases a streak of light green extending lengthwise. The worm is found in the straw just above the upper joint, where it devours the juices which would otherwise ascend to the head. The heads of the wheat denote its presence by turning white, prematurely, when the grain is in the milk. In one instance nine eggs were found in a single straw, one of which had just hatched. Have any of our readers seen any such insect?"

A later notice in the *Country Gentleman* of July 27th, 1854, may also allude to this species. Under date of July 8th, 1854, "W." of Oswego, N. Y., wrote to the editors of this journal inclosing a stem of wheat taken from his field, where the insects were destroying the grain by eating off the stem, just above the upper joint while yet in blossom. The statement was also made that the same insect had injured timothy in the same manner in that locality for several years, the trouble being attributed to wire-worms. The reply to this communication was that the editors had found two light-green pupæ, with slightly brownish heads, three-sixteenths of an inch in length and one-thirtieth of an inch in diameter, and consisting of nine rings or joints. They occupied the center of the stalk which they had partly devoured and killed, the head of the wheat being nothing but empty chaff, and nearly white in consequence of the death thus occasioned. The stalk was straight, and the sheaths entirely uninjured. "We have never met with the insect before and do not know it."

⁴⁵ First and Second Reports Ins. N. Y., pp. 297-9.

⁴⁶ *Memoirs of Penn. Agr. Society*, vol. 1, p. 165.

In the latter notice some obscurity is thrown upon the identity of the depredator, by there being two examples in a single straw and these having slightly brownish heads.

We next hear of the species as occurring in Missouri, where it was observed in June, 1867, by Prof. Riley, affecting wheat in fields between St. Louis and Bluffton, all such examined being injured from one to four per cent. As the adults were reared from infested straws there could be no doubt as to the identity of the larvæ, which were invariably eating the stems just above the upper joint⁴⁷

Aside from a note of inquiry, published in the Country Gentleman of July 22d, 1876, from "H. W." of Hinkley, Medina county, Ohio, who wished information in regard to a small white worm working above the joint nearest the head, there does not seem to be any further record of depredations of these larvæ until August, 1879. This time the larvæ were working in spring wheat, and specimens of the infested straws were forwarded to Prof. Lintner, through the editors of the Country Gentleman, by "W. P. S." of Scipioville, New York. These straws contained the larva and pupa, and from them there emerged August 5th two adults.⁴⁸

Up to this time no exact references to the depredations of the insect are to be found except in connection with the attack upon the full grown straw, just prior to harvest. There are, however, some indirect references which seem to indicate that the larvæ had been observed for many years in young wheat, both in spring and fall, as, for instance, the statement of Mr. Worth, as cited with reference to the joint worm. The first to call public attention to the injury to young wheat was Prof. S. A. Forbes, in 1883, the adult having been reared from larvæ found in young wheat, in the spring of that year, by Mr. John Martin, of Carbondale, Ill., and shortly after by Prof. Forbes at Normal, Illinois.⁴⁹ The first parasite, *Cælinius meromyzæ*, was also discovered, and described by Prof. Forbes in the report previously cited.

A *résumé* of the information secured up to this time may be given thus: Fitch observed adults in New York in June; Riley reared these from wheat straws in Missouri in June; Lintner reared adults from straws in New York in August; Forbes reared adults from pupæ in young wheat in Illinois, in April, and witnessed oviposition.

In northern Indiana, in 1884, we observed larvæ in dwarfed wheat plants on June 14th and in full grown straw on the 16th. Adults were observed in the same locality on June 6th. From straw, taken from the

⁴⁷ Rural New Yorker, Jan. 28th, 1869, First Rep. Ins. Mo. 1869, pp 159-61.

⁴⁸ First Ann Rep State Ent N. Y., p 221

⁴⁹ Prairie Farmer, May 29, 1883, Loc cit., Aug 4, 1883; 13th Rep State Ent. Ill. 1883, pp. 1-29, plate 1, Figs 1-8.

same field, adults were reared up to July 26, and the sexes were observed pairing on the 18th of same month.⁵⁰ From volunteer wheat, growing in this same field, adult flies were swept on September 5th, and from a quantity of the plants forwarded to Washington on the 6th, adult flies emerged on the 11th, 13th, and 16th of the same month.⁵¹ Others emerged in the same locality up to October 1st. As, from the large quantity of infested straws placed in the breeding cage every larva had transformed to the adult by the 26th of July, the appearance of these adults at this time, and emerging from volunteer wheat, was of itself strongly suggestive of a third brood. During July of 1886, adults were again observed in great numbers, they having emerged from wheat straws stored in a dark room with a single window. On August 31st a square foot of volunteer wheat, which, in view of the existing meteorological conditions, could not have been in existence prior to July 15th, and probably not before the 20th, was found to contain eleven puparia, two larvæ and one empty pupa.⁵²

The adults from these pupæ emerged from September 3d to 20th, being the most numerous on the 7th. That this data is to be relied upon is clearly shown by the abundance of adults occurring on the blossoms of buckwheat from September 3d to 25th, this plant being very attractive to them.⁵³

From the combined observations in the preceding it will be observed that the occurrence of a third brood scarcely admitted of a doubt.⁵⁴ Whatever doubt there was as to the occurrence of a third brood, originating largely at least, in very early sown or volunteer grain, seems to have been cleared up by Prof. Forbes finding both eggs and larvæ in abundance on August 4, 1886.⁵⁵

Prof. A. J. Cook⁵⁶ records the occurrence of these larvæ in both barley and oats in Michigan, and we have reared the adult from a larva found in a stem of blue grass, *Poa pratensis*. Mr James Fletcher states that the species in Canada breeds in *Agropyrum Deschampsia*, *Elymus* and *Poa*, one instance being observed in *Setaria viridis*.⁵⁷

The larva (Fig. 12), and puparia (Fig. 13), were first accurately described by Prof. Forbes⁵⁸ as well as the egg (Fig. 14), and manner of oviposition. His statement that in placing their eggs about the plants late in May, the females deposited them near the base of the plants, however affords a good illustration of the liability of our being misled by

50 Rep. Com. Agr., 1884, p. 390

51 Bull. tin 9 Purdue University, p. 5, Oct., 1886.

52 Loc. cit.

53 Rep. Com. Agr., 1886, p. 577.

54 Loc. cit., p. 574

55 Canadian Ent. Aug., 1886, p. 176

56 Prairie Farmer, Aug., 28, 1886

57 Entom. Americana, vol. VI, p. 2

58 Thirteenth Rep. St. Ent. Ill., p. 18.

the effects of artificial environments, as there is not the slightest evidence that this is ever done at that season of the year under natural surround-



FIG. 12.
Wheat Stem Maggot.
After Forbes.



FIG. 13.
Puparium of Wheat Stem
Maggot. After Forbes.



FIG. 14.
Egg of *Melomyza Americana*
greatly enlarged. After
Forbes.

ings, as the larvæ of these are always found above and never below the upper joint⁵⁹

In the ordinary course of things then, it may be said that in Ohio there are three generations of the insect each year. Further south there may be more, as we have found all stages of the insect in central Texas, late in February.⁶⁰ With us, however, we may look for the flies in our wheat fields in September and October, where the eggs are deposited upon the plants, the young maggots making their way downward to a point indicated by *a* in Fig. 15, where they feed upon the central part of the



FIG. 15.
Stem of young wheat. *a*, showing
location of wheat stem maggot
and the dead central leaf.

stem, cutting it entirely off, causing it to discolor and die. Here the larvæ pass the winter, emerging as adults (See Fig. 11) in the spring. These flies deposit eggs in such a position that the young maggots will readily reach the succulent part of the straw, just above the upper joint. The maggots remain here, feeding upon the stem, eventually killing it, thereby causing the upper portion of the straw and the head to wither and die. From these straws the adults emerge in July and deposit eggs in volunteer wheat and grass, the maggots working now precisely as later in the fall, and developing in time to escape again, as flies, and

deposit on young wheat in the fields in the fall.

⁵⁹ Rep. Com. Agr., 1884, p. —.

⁶⁰ Insect Life, vol. 3, p. 453.

The insect occurs from Canada south to Texas and northward probably to the Dakotas and Manitoba, thus practically covering the wheat area of eastern North America.

The pest is not so destructive as the Hessian fly, yet sometimes works serious destruction, and probably in this respect ranks with the joint worm and wheat straw worms. It is, however, vastly more difficult to destroy, and, feeding as it does in both grain and grasses, total destruction is impossible. As the adults emerge soon after harvest, it is clear that if the infested straw is left in the fields they will soon escape to deposit their eggs, but if the grain is stacked or threshed and the straw stacked or burned, the number escaping would be greatly reduced, as it is not likely that those in the center of the stacks would be able to make their way out, and the thrashing machine would likely destroy many. If plots of grain were sown immediately after harvest in the vicinity of such stacks, many of the females could no doubt be induced to deposit their eggs therein and these could be destroyed by plowing under. How much could be accomplished by late sowing of grain is uncertain, as the females are known to occur abundantly up to October.

From material secured in Illinois, Prof. Forbes reared a small Hymenopterous parasite, *Cælinus meromyza*, Forbes, but only from the spring brood of larvæ. We have twice, and during two seasons, reared the species in great numbers with the July appearing brood of adults, and also observed them in October. Besides this a species of the mite *Heteropus ventricosus*, Newport, was found to infest the larvæ in Indiana, in June, 1884.

THE COMPANION WHEAT FLY—*Oscinis*(?), Sp.?

There are probably several species of flies whose maggots depredate upon the wheat plant much as do those of *Meromyza*. Those under suspicion are for the most part at least, small dark colored flies resembling the house fly, except in not being over one-fourth as large. Some years ago we studied the habits of one of these in Indiana, and give here the results as published in 1886.⁶¹ There does not seem to be any great difference between its habits and those of the following, and the two may in future be found identical. It is also possible that we have here confused two or even three species. It will be seen that both this and the following have the same habit and periods of development as the wheat stem maggot, and therefore the remedies which may be found effective against one will probably prove equally valuable in fighting the others. Difficulty in the

⁶¹ Rep. Comm. Agr., 1886, p. 574.

determination of these small species of flies makes their study extremely unsatisfactory, and we were not always able to study the earlier stages

During the latter part of June, 1884, while examining wheat straws in which the larvæ of *Meromyza Americana* were at work, we often found several smaller larvæ, also dipterous, and so closely associated with the former that we at first suspected them of being parasites. They were almost invariably found among the juicy mass of substance that had been displaced by their larger consort.

Securing a supply of affected straws, we cut from each a section about three inches long, including the upper joint, but excluding the head, and placed them in a breeding jar. The result was, when the adult *Meromyza* emerged from these sections, July 18th to 23d, there appeared among them quite a number of a much smaller black species, closely resembling those of the genus *Oscinis*, but, however, being quite distinct.

Early in the following September larvæ, seemingly like those observed in the straw, were found feeding within the stems of young volunteer wheat plants, and later the same thing was observed to destroy young plants in a field of early sown wheat.

From this volunteer wheat adult flies of the species now under consideration emerged from September 7th to October 1st. The present season they began to emerge August 30th, in both cases being the most numerous about the 10th of September. We have also reared adults from larvæ in wheat sown during the last week of August, these emerging as late as the 3d of October. The adults are common in wheat fields after about September 10th, until the 1st of October, and hover about the young plants, doubtless for the purpose of ovipositing, as they are often observed pairing.

We have never observed them during late fall or early spring. They are sometimes attacked by a fungous parasite very similar to, if not identical with, that attacking the house fly.

The larvæ are much smaller than those of *Meromyza*, but in a general way resemble them in form and color, particularly when the latter are only partly grown.

The puparia are, however, very different, being only about 2.5 m. m. long and 0.8 m. m. broad. The color is never like that of *Meromyza*, being at first of a yellowish white, with tinge of green, but later changing to a uniform brown. They are readily distinguished from those of the Hessian fly by being cylindrical and by the segments being well defined.

From the foregoing it will be observed that, so far as we have been able to study the species, its cycle is exactly parallel with that of the *Meromyza*, and, besides, there is a strong probability that while in young wheat the larvæ work independently, in the full grown straws, where the

tissue is too tough for their less rugged mouth parts, they become the messmates of their stronger consort, and feed from the vegetable juices by which it is surrounded. It is this characteristic that suggested the common appellation selected.

The damage done to young wheat in the fall by this species must be considerable, the credit thereof falling upon the *Meromyza*, as the effect of the two larvæ is exactly the same.

THE AMERICAN FRIT FLY*—*Oscinis variabilis*(?), Loew.

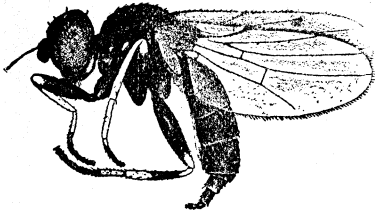


FIG. 16.

American Frit Fly, adult. After Garman.

In the autumn of 1889 Prof. H. Garman, of the Kentucky Agricultural Experiment Station, reared from volunteer wheat in that state a small black fly somewhat resembling a small house fly. (Fig. 16.) The larva or maggot (Fig. 17), infested the central portion of the plant, causing the latter to wither and die, precisely as if attacked by the wheat stem maggot, but after reaching its

growth this maggot transformed into a small brown puparian (Fig. 18). Prof. Garman has reared the adults in both fall and spring and found the larvæ in young wheat plants only.⁶²



FIG. 17.

Larva or maggot of American Frit Fly. After Garman.



FIG. 18.

Puparium of American Frit Fly. After Garman.

Prof. James Fletcher has found what appears to be the same species very destructive in spring sown wheat and grasses in Canada.⁶³

So far as studied by these gentlemen this pest seems to appear in spring and fall simultaneously with the wheat stem maggot, and its larva works in precisely the same manner, so much so that it is impossible to detect the difference without a critical examination of the culprit.

* The illustrations here used in connection with this species are about fifteen times larger than natural size, and are used through the courtesy of the Kentucky Experiment Station.

⁶² Kentucky Agl. Exp. Sta., of State College, Bulletin 30, pp. 16-20, August, 1890.

⁶³ Insect life, vol. 3, p. 82.

SUMMARY

The Joint Worm, Wheat Straw Worm and Wheat Stem Saw-fly all belong to the same order of insects as the ant, bee and wasp. The eggs are deposited in the growing stems, and the insect passes the fall and winter in the stubble.

Burning the stubble will probably destroy the majority of the insects in a field, while a rotation of crops will do much to prevent their becoming abundant.

The Grain Sphenophorus destroys wheat by burrowing in the basal joints of the straw. This is one of quite a number of species which do serious injury to corn, being known as corn Bill-bugs.

The Stalk borer is a near relative of the cut-worm and army worm, but departs from the habits of these last by burrowing in the stems of wheat and other grains. Little damage is done to wheat, its chief injury being among corn and vegetables.

The Wheat Stem Maggot is the young of a small fly which deposits its eggs on the leaves of growing wheat and grass in spring, summer and fall. The maggots burrow in and destroy the tender, growing stems, and are particularly noticeable in wheat fields just before harvest, when they work just above the upper joint, causing the heads of the grain to wither and turn white. At other times they cause the center of the plant to turn yellow and die. Sowing plats of wheat in mid-summer, and plowing these under in September, will destroy many of the larvæ, as will also the destruction of volunteer wheat. Some varieties of wheat are attacked more severely than others.

The Companion Wheat-fly and the *American Frit-fly* are small dark colored flies resembling minute house flies. The habits of their larvæ are much the same as those of the wheat stem maggot, and similar remedies and preventives will probably be found equally effective.

This page intentionally blank.

ANNOUNCEMENT.

The Consulting Entomologist has not been connected with the Experiment Station a sufficient time to become well acquainted, either with the State or its people, and, therefore, wishes to say that he is desirous of receiving information and specimens of injurious insects of all kinds and from all parts of the State. Where the depredations warrant doing so, he will probably be able to visit localities and fields, in person, and study the pests or devise means for destroying them. Hence, it is not only very desirable, but essential, that, when any such depredations are observed, whether they appear to be little or great, those who observe them should promptly place themselves in correspondence with the Station, giving as full information as practicable of the nature of the trouble, accompanied by specimens if possible. These last should never be put in a letter, but placed alive in a tight box and securely wrapped, with food to last them on their journey. Postage on packages of this sort is one cent per ounce.

Address,

EXPERIMENT STATION,
Columbus, Ohio.